

# **Health & Safety Manual**

**Supplement 10.08**

## **Hearing Conservation**

**January 1996**

**Approved by the ES&H Working Group**

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# Hearing Conservation\*

## Contents

1.0	Introduction.....	1
2.0	Requirements/Regulatory Summary .....	1
3.0	Applicability.....	1
4.0	Process for Risk Reduction .....	2
4.1	Limits for Exposure to Potentially Hazardous Noise.....	3
4.1.1	Eight-hour, Time-weighted Average Exposure Limits .....	3
4.1.2	Maximum Noise Exposure.....	4
4.1.3	Maximum Exposure to Upper Sonic and Ultrasonic Noise .....	4
4.2	Speech Interference and Annoying Noise .....	4
4.2.1	Speech Interference .....	4
4.2.2	Annoying Noise.....	4
4.3	Measurement of Noise.....	4
4.4	Medical Surveillance .....	6
4.5	Control of Exposure to Noise.....	7
4.5.1	Engineering Controls.....	8
4.5.2	Administrative Controls.....	8
4.5.3	Hearing Protectors .....	8
5.0	Responsibilities .....	9
5.1	Hazards Control Department.....	9
5.2	Health Services Department .....	10
5.3	Plant Engineering .....	10
5.4	Facility Managers and Supervisors.....	10
5.5	Employees.....	11
6.0	Training .....	11
7.0	LLNL Contact.....	11
7.0	Supporting References and Standards .....	12
	Appendix A Process for Controlling Excessive Noise Levels .....	13

# **Hearing Conservation**

## **1.0 Introduction**

Many operations and pieces of equipment used at LLNL produce noise. Exposure to excessive levels of noise can result in a permanent loss of hearing acuity, development of tinnitus (i.e., ringing of the ears), a possible increase in blood pressure, and stress-related problems. Noise may also cause annoyance or difficulty in communicating or working effectively and safely. Thus, a Hearing Conservation Program must be instituted to protect employees from harmful noise. This program involves

- Identification of exposed personnel (monitoring).
- Implementation of noise-reducing engineering and administrative controls.
- Use of hearing protectors (plugs, ear muffs).
- Audiometric testing (baseline and annual).
- Training.

This supplement provides guidelines for the implementation of a Hearing Conservation Program.

## **2.0 Requirements/Regulatory Summary**

The standards set forth in this supplement for preventing hearing loss are based on 29 CFR 1910.95 and the Threshold Limit Values (TLV) established by the American Conference of Governmental Industrial Hygienists (ACGIH). The guidance provided for controlling “annoying” noise is based on best management practice and therefore is not mandatory.

## **3.0 Applicability**

This supplement is applicable to all LLNL employees and subcontractors who may be exposed to excessive noise levels and to both construction and non-construction work.

## 4.0. Process for Risk Reduction

Noise is the perception of pressure waves in the air caused by a vibrating source. The ears transduce this mechanical energy to electrochemical impulses that are transmitted to the brain, resulting in the perception of sound. Figure 1 shows the sound pressure levels on the decibel scale, with a reference sound pressure of 20  $\mu\text{Pa}$ , for various types of equipment and areas where these noise levels may be encountered.

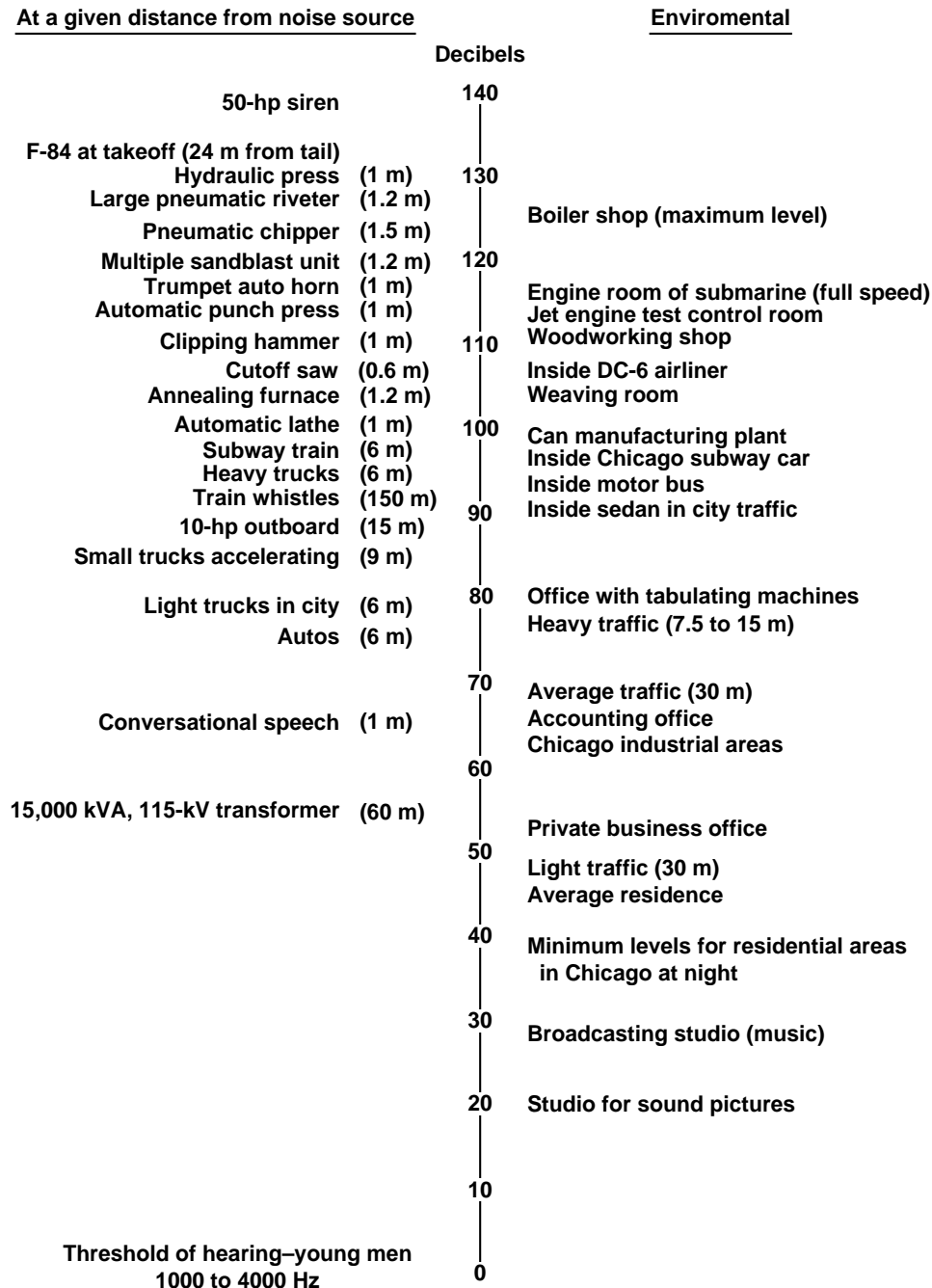


Figure 1. Typical overall sound-pressure level.

## 4.1 Limits for Exposure to Potentially Hazardous Noise

### 4.1.1 Eight-hour, Time-weighted Average Exposure Limits

The OSHA permissible exposure limit (PEL) for an 8-hour, time-weighted average exposure is 90 decibels (dB) of sound pressure measured on the A-weighted scale (dBA). The ACGIH has established a more restrictive standard of 85 dBA over an 8-hour day. Because both are applicable and mandatory, the more restrictive standard of 85 dBA serves as the standard at LLNL. Exposure to transient noise louder than 85 dBA is permitted, as long as the average exposure for the entire day is less than 85 dBA. A three-decibel exchange rate is used. Table 1 shows the relationship between noise levels and permitted exposure periods.

**Table 1. Threshold limit value for noise.<sup>a</sup>**

	<b>Duration/day</b>	<b>Sound level, dBA<sup>b</sup></b>
<b>Hours</b>	<b>24</b>	<b>80</b>
	<b>16</b>	<b>82</b>
	<b>8</b>	<b>85</b>
	<b>4</b>	<b>88</b>
	<b>2</b>	<b>91</b>
	<b>1</b>	<b>94</b>
<b>Minutes</b>	<b>30</b>	<b>97</b>
	<b>15</b>	<b>100</b>
	<b>7.50<sup>c</sup></b>	<b>103</b>
	<b>3.75<sup>c</sup></b>	<b>106</b>
	<b>1.88<sup>c</sup></b>	<b>109</b>
	<b>0.94<sup>c</sup></b>	<b>112</b>
<b>Seconds<sup>c</sup></b>	<b>28.12</b>	<b>115</b>
	<b>14.06</b>	<b>118</b>
	<b>7.03</b>	<b>121</b>
	<b>3.53</b>	<b>124</b>
	<b>1.76</b>	<b>127</b>
	<b>0.88</b>	<b>130</b>
	<b>0.44</b>	<b>133</b>
	<b>0.22</b>	<b>136</b>
	<b>0.11</b>	<b>139</b>

<sup>a</sup>No exposure to continuous, intermittent, or impact noise in excess of a peak C-weighted level of 140 dB.

<sup>b</sup>Sound level in decibels are measured on a sound level meter, conforming as a minimum to the requirements of the American National Standards Institute Specification for Sound Level Meters, S1.4 (1984) Type S2A, and set to use the A-weighted network with slow meter response.

<sup>c</sup>Limited by the noise source—not by administrative control.

#### **4.1.2 Maximum Noise Exposure**

For most practical purposes, exposure to noise above 115 dBA for any length of time is not permitted unless hearing protection is worn. The maximum exposure limit for impulse noise is 140 dB (unweighted or C-weighted).

#### **4.1.3 Maximum Exposure To Upper Sonic and Ultrasonic Noise**

The ACGIH has established a standard for exposure to very high audible frequencies and frequencies above the range of human hearing. This standard covers noise from 10,000 to 50,000 Hz (kHz), which is measured at the mid-frequency of the third octave band (see Table 2).

### **4.2 Speech Interference and Annoying Noise**

In some cases noise does not exceed standards established to protect hearing, but does interfere with speech or can cause annoyance. For example, nuisance noise can prevent effective communication between two or more employees working together as well as irritate employees, thereby reducing productivity. Although there are no mandatory standards for nuisance noise in the occupational setting, the guidelines and recommendations available should be followed to protect employees from exposure to this type of noise.

#### **4.2.1 Speech Interference**

Most of the information conveyed through speech is in the mid-frequencies—from about 500 to 2000 Hz. Thus, these are the frequencies that are used to determine how noise will interfere with speech. Figure 2 shows the relationship of noise levels averaged over bands at 500, 1000, and 2000 Hz (as measured in dB) and the subjective effect on communication in offices, conference rooms, secretarial areas, drafting areas, and business machine areas. Noise levels above 60 dB make telephone conversation difficult. A level below 50 dB is desirable in a typical conference room; those above 70 dB often present a problem in such settings.

#### **4.2.2 Annoying Noise**

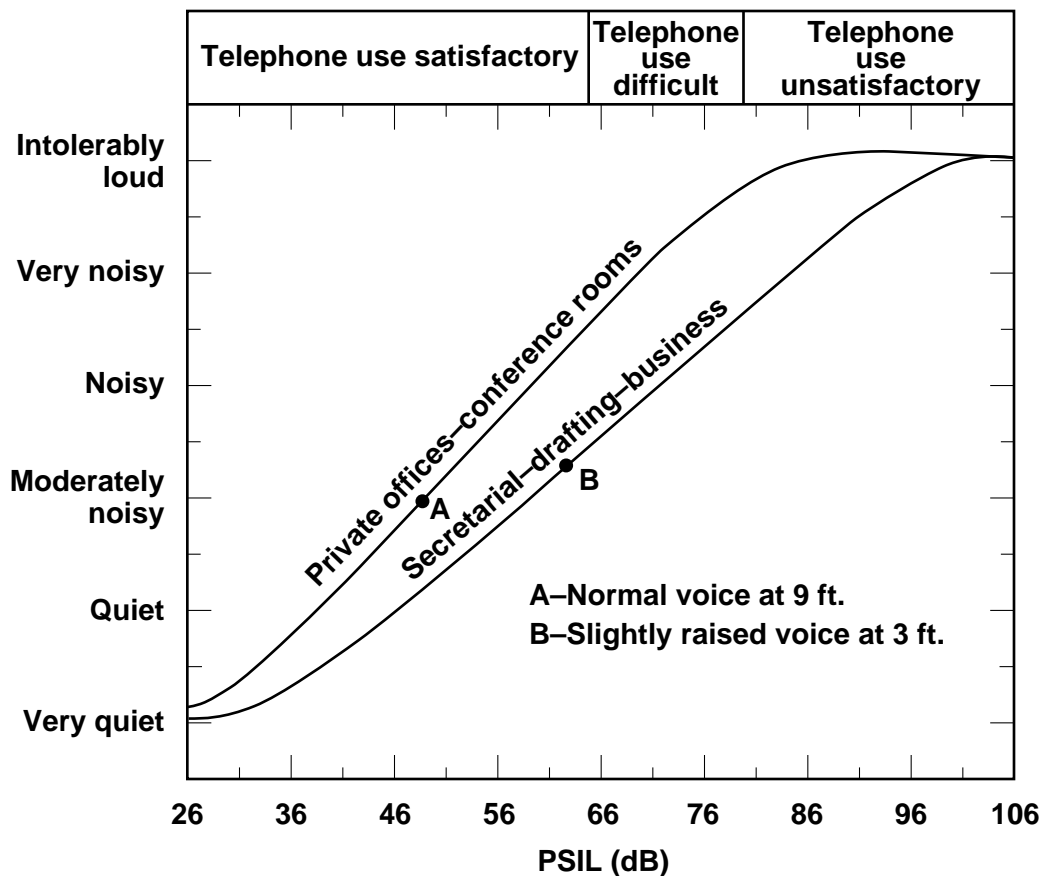
Noise may be annoying because of its level, frequency, or aspects of its modulation. A noise may not be very loud, but its frequency may be high enough to cause headaches in susceptible individuals. Alternatively, a noise may not be that loud but may start and stop suddenly. This can disturb concentration or frighten exposed personnel. Because there are no guidelines for annoying noise, each case must be examined independently to attempt to alleviate the irritation.

### **4.3 Measurement of Noise**

Supervisors responsible for employees who may be exposed to loud noise must notify their ES&H team. The team's industrial hygienist or health and safety technician usually performs noise measurements, which may be taken

**Table 2. Permissible airborne upper sonic and ultrasound acoustic radiation exposure levels.**

Mid-frequency of third octave band (kHz)	One-third octave band level in dB (re 20 $\mu$ Pa)
10	80
12.5	80
16	80
20	105
25	110
31.5	115
40	115
50	115



**Figure 2. Rating chart for office noises. PSIL is the average of sound levels in bands at 500-, 1000-, and 2000-Hz. Criterion points A and B designate desirable upper noise limits for intelligible conversation. These data points were determined by octave-band analysis and correlated with subjective tests.**

to identify areas or specific operations that produce excessive noise or to evaluate an employee's exposure to noise throughout an 8-hour day. The results of the measurements are used to determine which, if any, controls are appropriate to reduce employee exposure to noise.

Hazards Control will notify supervisors in writing of employees who are confirmed to be exposed to excessive levels of noise, regardless of the use of hearing protectors. Notification will include a statement regarding the supervisor's responsibility to enroll the employee(s) in a medical surveillance program, implement feasible engineering controls, or provide hearing protectors. A copy of the notice will be provided to Health Services.

#### **4.4 Medical Surveillance**

Medical surveillance examinations are conducted to monitor the hearing acuity of employees exposed to noise at levels exceeding the limits established in Section 4.1. Medical surveillance is not routinely required for employees who are exposed to noise exceeding the nuisance levels described in Section 4.2. Health Services only performs medical surveillance for LLNL employees, but equipment and training provided to LLNL employees will be available to non-LLNL employees. Non-LLNL employees should receive medical surveillance through their employer.

Supervisors are required to enroll employees affected by noise in the Hearing Conservation Program administered by Health Services. This program shall meet all the requirements of 29 CFR 1910.95 and include

- Annual education on the health effects of noise exposure and instructions on how to fit and wear hearing protectors.
- A baseline exam and annual follow-up audiometric testing.

Health Services will schedule audiometric testing and advise employees to wear hearing protectors or avoid noisy environments for 14 hours before the test. If this test shows that an employee may have suffered a standard threshold shift, Health Services may schedule a retest within 30 days and consider the results of this test as the annual audiogram. Health Services will determine if the shift is occupational or non-occupational and notify the employee in writing within 21 days of the determination. If the shift is occupational, Health Services will

- Refer the employee to Hazards Control for possible re-evaluation of his/her workplace.
- Fit and train the employee in the use of hearing protectors (plugs) if none is used, and notify the employee's supervisor that the employee must wear hearing protectors.



- Assess the employee's level of knowledge in the types and use of hearing protection to augment knowledge deficits, that is, if the employee is already using hearing protectors. If the employee needs hearing protectors with greater attenuation, Health Services will inform the employee's supervisor and the cognizant industrial hygienist. Then it shall be the responsibility of the supervisor to provide such hearing protectors.

Health Services may also require the employee to undergo further clinical audiological evaluation or otological examination if it is determined that such evaluation or examination is necessary, or if the Department suspects that a medical pathology of the ear is caused or aggravated by the wearing of hearing protectors.

## **4.5 Control of Noise Exposure**

The three ways to reduce employee noise exposure are through the use of

- Engineering controls.
- Administrative controls.
- Hearing protectors.

Hearing protectors (e.g., ear plugs, canal caps, and ear muffs) should only be used as a last resort after engineering and administrative measures have been implemented and further protection is still needed or during the design and fabrication of suitable enclosures, sound damping materials, and isolation. Whenever employees are subjected to noise exceeding the limits established in Section 4.1, Hazards Control will assist in the design of feasible administrative and engineering controls and will re-evaluate the employee and his/her work area after implementation of these controls. If the controls fail to reduce the noise levels below the limits established in Section 4.1, then

- Hazards Control shall notify the employee's supervisor and Health Services, as described in Section 4.4.
- The supervisor shall enroll the employee in the Hearing Conservation Program and course HS4360.
- The supervisor shall require the employee to wear hearing protection.

This procedure shall be followed, as determined by the cognizant industrial hygienist, in cases where there is a significant delay in implementing engineering controls and employees will be exposed to excessive levels of noise in the interim.

For each employee who is enrolled in the Hearing Conservation Program, Health Services shall demonstrate and train employees in the use of various hearing protectors at the initial medical surveillance appointment. Supervisors shall provide all employees in the Program with hearing

protectors and require these employees to use them. Hearing protectors are available from LLNL Stores.

#### **4.5.1 Engineering Controls**

The best way to limit noise exposure is to alter the noise-producing equipment or change the environment to reduce noise levels. Examples may include replacing old, noisy equipment; increasing sound dampening around noisy equipment; and improving muffler design. Engineering controls must be formally considered before other types of controls are implemented. Contact your area ES&H team for assistance in reviewing the options for engineering controls.

#### **4.5.2 Administrative Controls**

Another way to limit noise exposure is to alter the work rules. For example, an employee scheduled to work on several pieces of noisy equipment should perform his/her tasks over several days so that the average exposure on each day does not exceed the permissible limit.

In addition, caution labels or signs should be posted on equipment or in areas where it has been determined that noise levels may exceed 85 dbA. Similarly, a warning sign should be posted on equipment and in areas where it has been determined that noise levels (other than impact or impulse noise) may exceed 90 dbA. These signs should notify the worker of a potential noise hazard and specify the conditions under which hearing protectors are recommended or required. Caution labels and signs are particularly important where workers' duties require them to move among different locations or use a variety of tools. The purpose and meaning of the signs shall be included in the training aspect of the Hearing Conservation Program.

#### **4.5.3 Hearing Protectors**

Hearing protectors should only be used as a last resort after engineering and administrative measures have been implemented and further protection is still needed or during the design and fabrication of suitable enclosures, sound dampening materials, and isolation. Health Services will demonstrate various types of hearing protectors at the medical surveillance appointment and provide an initial set of ear plugs to individuals if they so desire. Thereafter, supervisors shall provide employees affected by noise with ear plugs and ear muffs as needed. These items are available from LLNL Stores.

Hearing protectors must provide adequate attenuation so that employees are not exposed to excessive noise levels. Each hearing protector provided by the manufacturer has a "noise-reduction rating" (NRR) number, which is a general guide to the level of noise reduction (in decibels) the protector will provide if it is fitted and worn properly. The effective NRR is less than the labeled NRR (Effective NRR (bd) = Labeled NRR - 10).

Supervisors may select hearing protectors for employees affected by noise at levels up to 95 dbA, but should contact the ES&H team industrial hygienist to select the appropriate type of hearing protector for areas where exposure above 95 dbA is possible. Generally, ear muffs are more likely to be worn correctly than are ear plugs; thus, the actual noise reduction provided by ear muffs in the field is closer to the stated value.

## **5.0 Responsibilities**

### **5.1 Hazards Control Department**

Hazards Control is responsible for

- Reviewing Laboratory operations to determine if there is a potential for exposure to hazardous or annoying levels of noise.
- Evaluating employees' concerns regarding noise levels in the workplace.
- Maintaining an adequate collection of noise-monitoring equipment, including sound-level meters, octave-band analyzers, dosimeters, and calibrators.
- Conducting noise surveys to establish the noise levels at various work sites; and posting the appropriate signs in specific areas, operations, or on equipment that may expose employees to noise above 85 dBA.
- Where feasible, conducting dosimetric noise surveys on employees who may be exposed to noise levels that exceed the permissible limits.
- Notifying supervisors in writing of those employees found to be exposed to noise levels that exceed the permissible limits, and advising supervisors that these employees must participate in annual audiometric testing offered by Health Services and training offered by Hazards Control.
- Assisting with the design of engineering controls to reduce employee exposure to noise.
- Providing course HS4360 to employees who have been exposed to noise that exceeds the applicable standards.
- Selecting the most appropriate type of hearing protectors for employees exposed to noise at levels above 95 dbA.

## **5.2 Health Services Department**

Health Services is responsible for

- Establishing and maintaining an audiometric testing program in accordance with 29 CFR 1910.95.
- Providing employees with annual education on the health effects of noise exposure, instructions on how to fit and wear hearing protectors, and a baseline examination and annual follow-up audiometric testing. These are all part of LLNL's Hearing Conservation Program.
- Providing one set of ear plugs to employees who are newly enrolled in the audiometric testing program.
- Referring employees with apparent work-related threshold shifts that are significant to Hazards Control for re-evaluation of the worksite.

## **5.3 Plant Engineering**

Plant Engineering is responsible for

- Ensuring that the stipulations and exposure limits described in this supplement are included in specifications and contract documentation for work to be performed by subcontractors.
- Adequately maintaining infrastructure equipment to minimize the generation of noise.

## **5.4 Facility Managers and Supervisors**

Facility Managers and supervisors are responsible for

- Informing Hazards Control of personnel who are potentially exposed to hazardous levels of noise.
- Ensuring that the noise level of equipment to be acquired is considered in the purchasing process.
- Enrolling employees found to be exposed to noise levels that exceed the permissible limits in LLNL's Hearing Conservation Program or to an outside provider for non-LLNL employees.
- Enforcing the use of hearing protectors where required.
- Ensuring that engineering controls (e.g., enclosure and sound dampening) are used on equipment that generates potentially hazardous noise levels.

## **5.5 Employees**

Employees shall

- Contact their supervisors and Hazards Control (ext. 2-5128) if noise levels in the workplace is of concern.
- Use hearing protectors where required and adhere to signs identifying noisy areas.
- Participate in required medical exams, required education, and demonstrations on how to properly fit protectors offered by Health Services and in required training offered by Hazards Control.

## **6.0 Training**

Employees who are exposed to noise exceeding the 8-hour time-weighted average (85 dBA) or the peak (140 dB) must take course HS4360, "Noise." This course is offered by Hazards Control and covers the following

- The effects of noise on hearing.
- When and/or where hearing protectors are required.
- The purpose of hearing protectors.
- The advantages, disadvantages, and attenuation of various types of protectors.
- Instructions on how to select, use, fit, and care for hearing protectors.
- The purpose of audiometric testing, including an explanation of the test procedures.

Follow-up annual retraining shall be provided by Health Services at the time of annual audiometric testing.

## **7.0 LLNL Contacts**

Contact the appropriate organization or group for further information on the following:

- Audiometric testing—Health Services (ext. 2-7459)
- Exposure monitoring—ES&H team
- Training—Safety Analysis and Training Group in the Hazards Control (ext. 2-1217)

## **8.0 Supporting References and Standards**

Code of Federal Regulations, Title 29, Part 1910.95, *Occupational Noise Exposure*,” Office of the Federal Register, Washington, DC.

American Conference of Governmental Industrial Hygienists, *Threshold Limit Values for Physical Agents in the Work Environment*, ACGIH, Cincinnati, OH (latest edition).

## Appendix A

### Process for Controlling Excessive Noise Levels

